AAS

227TH MEETING

AMERICAN ASTRONOMICAL SOCIETY

KISSIMMEE, FL • 4-8 JANUARY 2016

Rebecca Coles, 01-19-2016

Interesting Posters and Presentations Summary

Posters:

- Verification of Absolute Calibration of Quantum Efficiency for LSST CCDs
- The Effects of Commercial Airline Traffic on LSST Observing Efficiency
- An Investigation of CCD Charge Transfer and Detector Anomalies for a Low Light Level Application
- Do Single-Degenerate Type Ia Supernovae Generally Lead to Normal Type Ia Supernovae?

Presentations:

- LSST Observing Strategy

Workshops:

- Bayesian Methods in Astronomy: Hands-on Statistics

Verification of Absolute Calibration of Quantum Efficiency for LSST CCDs

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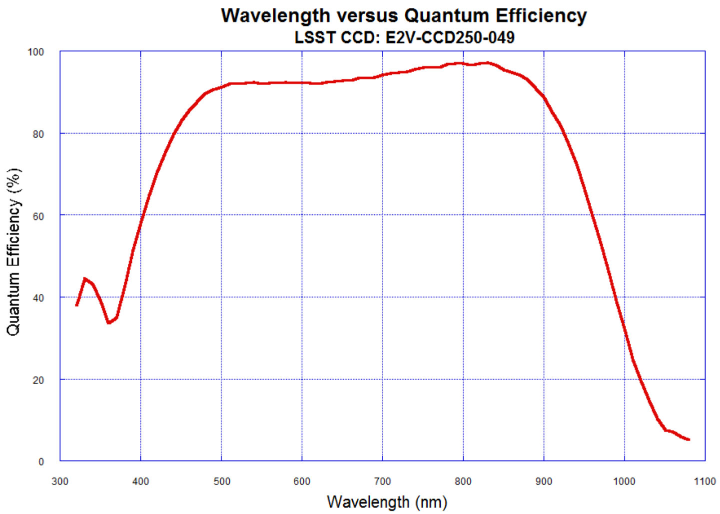
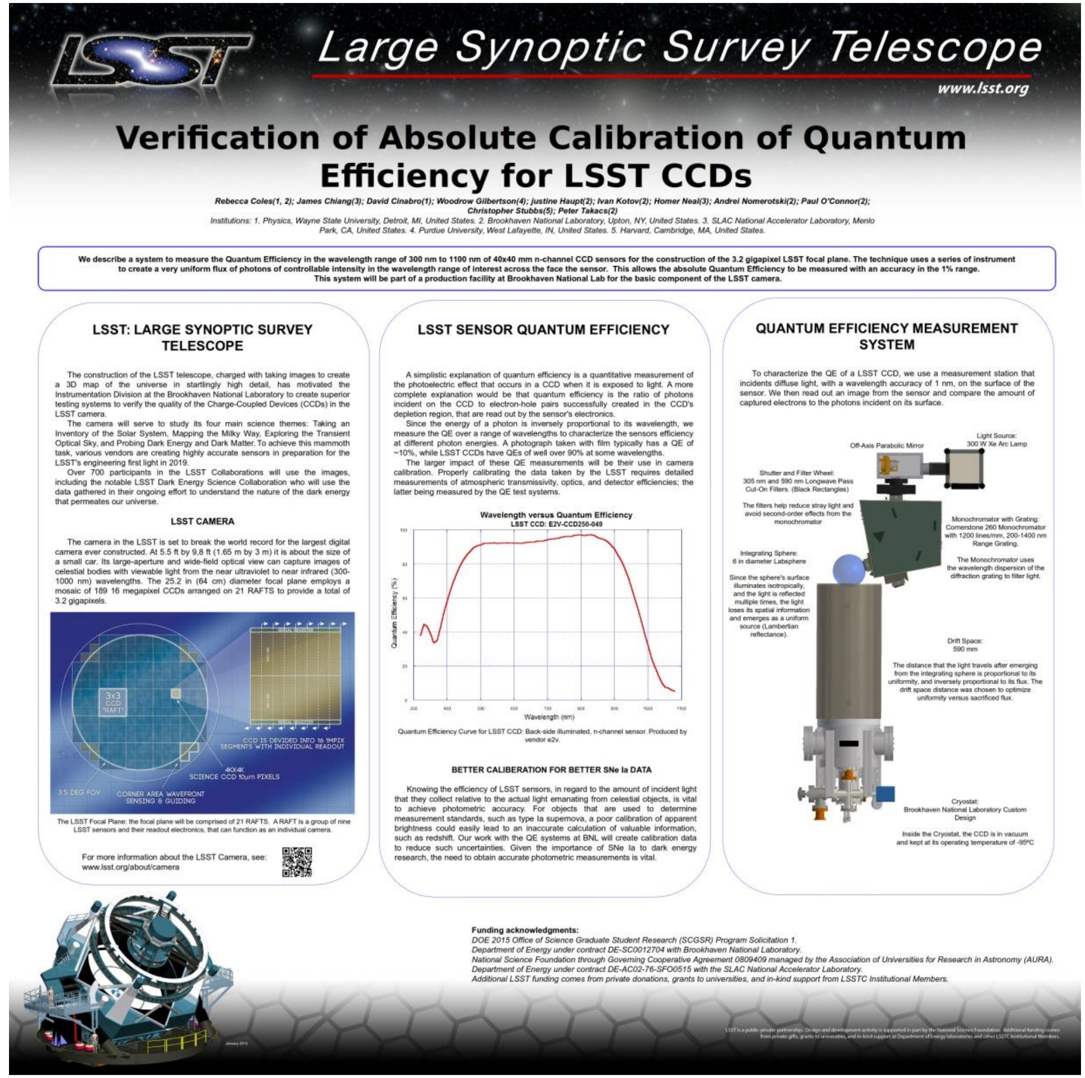
Coles, Rebecca ; Chiang, James ; Cinabro, David ; Gilbertson, Woodrow ; Haupt, Justine ; Kotov, Ivan ; Neal, Homer ; Nomerotski, Andrei ; O'Connor, Paul ; Stubbs, Christopher ; Takacs, Peter

Abstract:

We describe a system to measure the Quantum Efficiency in the wavelength range of 300nm to 1100nm of 40x40 mm n-channel CCD sensors for the construction of the 3.2 gigapixel LSST focal plane. The technique uses a series of instruments to create a very uniform flux of photons of controllable intensity in the wavelength range of interest across the face of the sensor. This allows the absolute Quantum Efficiency to be measured with an accuracy in the 1% range. This system will be part of a production facility at Brookhaven National Lab for the basic components of the LSST camera.





Large Synoptic Survey Telescope

www.lsst.org

Verification of Absolute Calibration of Quantum Efficiency for LSST CCDs

Rebecca Coles(1, 2); James Chiang(3); David Cinabro(1); Woodrow Gilbertson(4); justine Haupt(2); Ivan Kotov(2); Homer Neal(3); Andrei Nomerotski(2); Paul O'Connor(2); Christopher Stubbs(5); Peter Takacs(2)

Institutions: 1. Physics, Wayne State University, Detroit, MI, United States. 2. Brookhaven National Laboratory, Upton, NY, United States. 3. SLAC National Accelerator Laboratory, Menlo Park, CA, United States. 4. Purdue University, West Lafayette, IN, United States. 5. Harvard, Cambridge, MA, United States.

We describe a system to measure the Quantum Efficiency in the wavelength range of 300 nm to 1100 nm of 40x40 mm n-channel CCD sensors for the construction of the 3.2 gigapixel LSST focal plane. The technique uses a series of instrument to create a very uniform flux of photons of controllable intensity in the wavelength range of interest across the face the sensor. This allows the absolute Quantum Efficiency to be measured with an accuracy in the 1% range. This system will be part of a production facility at Brookhaven National Lab for the basic component of the LSST camera.

LSST: LARGE SYNOPTIC SURVEY TELESCOPE

The construction of the LSST telescope, charged with taking images to create a 3D map of the universe in startlingly high detail, has motivated the Instrumentation Division at the Brookhaven National Laboratory to create superior testing systems to verify the quality of the Charge-Coupled Devices (CCDs) in the LSST camera.

The camera will serve to study its four main science themes: Taking an Inventory of the Solar System, Mapping the Milky Way, Exploring the Transient Optical Sky, and Probing Dark Energy and Dark Matter. To achieve this mammoth task, various vendors are creating highly accurate sensors in preparation for the LSST's engineering first light in 2019.

Over 700 participants in the LSST Collaborations will use the images, including the notable LSST Dark Energy Science Collaboration who will use the data gathered in their ongoing effort to understand the nature of the dark energy that permeates our universe.

LSST CAMERA

The camera in the LSST is set to break the world record for the largest digital camera ever constructed. At 5.5 ft by 9,8 ft (1.65 m by 3 m) it is about the size of a small car. Its large-aperture and wide-field optical view can capture images of celestial bodies with viewable light from the near ultraviolet to near infrared (300-1000 nm) wavelengths. The 25.2 in (64 cm) diameter focal plane employs a mosaic of 189 16 megapixel CCDs arranged on 21 RAFTS to provide a total of 3.2 gigapixels.

The LSST Focal Plane: the focal plane will be comprised of 21 RAFTS. A RAFT is a group of nine LSST sensors and their readout electronics, that can function as an individual camera.

For more information about the LSST Camera, see: www.lsst.org/about/camera

LSST SENSOR QUANTUM EFFICIENCY

A simplistic explanation of quantum efficiency is a quantitative measurement of the photoelectric effect that occurs in a CCD when it is exposed to light. A more complete explanation would be that quantum efficiency is the ratio of photons incident on the CCD to electron-hole pairs successfully created in the CCD's depletion region, that are read out by the sensor's electronics.

Since the energy of a photon is inversely proportional to its wavelength, we measure the QE over a range of wavelengths to characterize the sensors efficiency at different photon energies. A photograph taken with film typically has a QE of ~10%, while LSST CCDs have QEs of well over 90% at some wavelengths.

The larger impact of these QE measurements will be their use in camera calibration. Properly calibrating the data taken by the LSST requires detailed measurements of atmospheric transmissivity, optics, and detector efficiencies; the latter being measured by the QE test systems.

Quantum Efficiency Curve for LSST CCD: Back-side illuminated, n-channel sensor. Produced by vendor e2v.

BETTER CALIBERATION FOR BETTER SNe Ia DATA

Knowing the efficiency of LSST sensors, in regard to the amount of incident light that they collect relative to the actual light emanating from celestial objects, is vital to achieve photometric accuracy. For objects that are used to determine measurement standards, such as type Ia supernova, a poor calibration of apparent brightness could easily lead to an inaccurate calculation of valuable information, such as redshift. Our work with the QE systems at BNL will create calibration data to reduce such uncertainties. Given the importance of SNe Ia to dark energy research, the need to obtain accurate photometric measurements is vital.

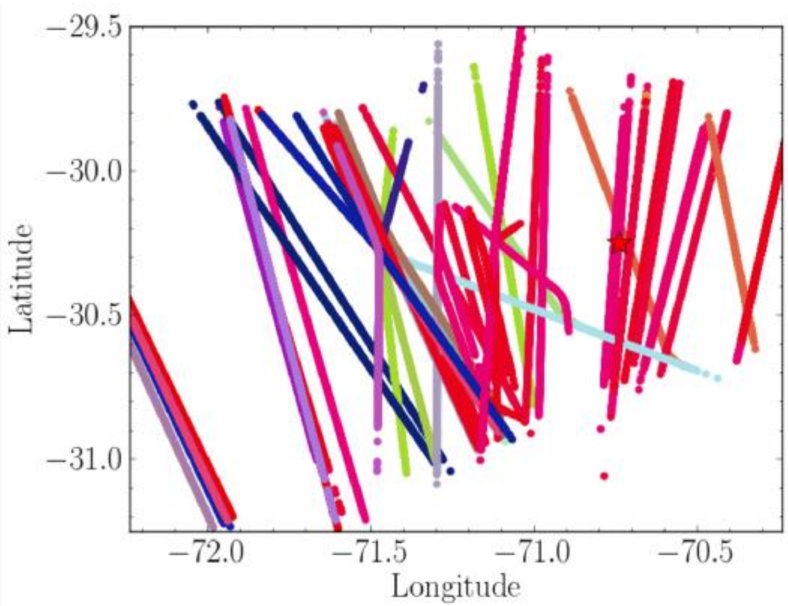
QUANTUM EFFICIENCY MEASUREMENT SYSTEM

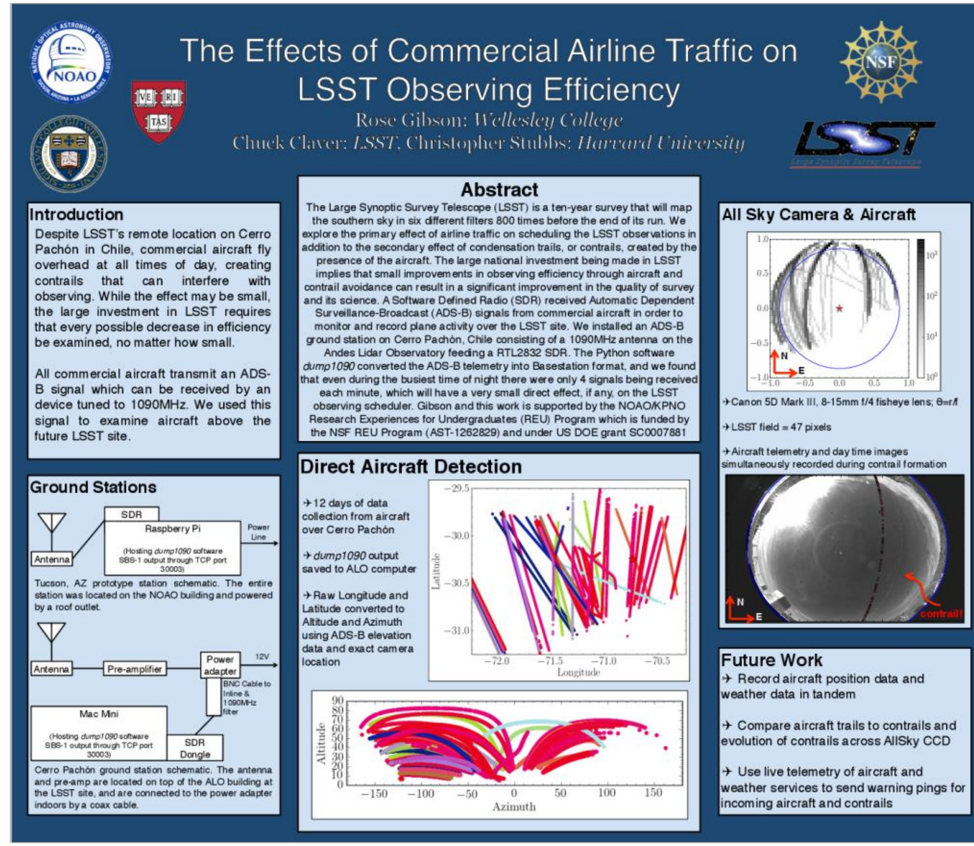
To characterize the QE of a LSST CCD, we use a measurement station that incidents diffuse light, with a wavelength accuracy of 1 nm, on the surface of the sensor. We then read out an image from the sensor and compare the amount of captured electrons to the photons incident on its surface.

Funding acknowledgments:
DOE 2015 Office of Science Graduate Student Research (SCGSR) Program Solicitation 1.
Department of Energy under contract DE-SC0012704 with Brookhaven National Laboratory.
National Science Foundation through Governing Cooperative Agreement 0809409 managed by the Association of Universities for Research in Astronomy (AURA).
Department of Energy under contract DE-AC02-76-SFO0515 with the SLAC National Accelerator Laboratory.
Additional LSST funding comes from private donations, grants to universities, and in-kind support from LSSTC Institutional Members.

The Effects of Commercial Airline Traffic on LSST Observing Efficiency

Gibson, Rose ; Claver, Chuck ; Stubbs, Christopher





Abstract:

The Large Synoptic Survey Telescope (LSST) is a ten-year survey that will map the southern sky in six different filters 800 times before the end of its run. In this paper, we explore the primary effect of airline traffic on scheduling the LSST observations in addition to the secondary effect of condensation trails, or contrails, created by the presence of the aircraft. The large national investment being made in LSST implies that small improvments observing efficiency through aircraft and contrail avoidance can result in a significant improvement in the quality of the survey and its science. We have used the Automatic Dependent Surveillance-Broadcast (ADS-B) signals received from commercial aircraft to monitor and record activity over the LSST site. We installed a ADS-B ground station on Cerro Pachón, Chile consiting of a1090Mhz antenna on the Andes Lidar Observatory feeding a RTL2832U software defined radio. We used dump1090 to convert the received ADS-B telementry into Basestation format, where we found that during the busiest time of the night there were only 4 signals being received each minute on average, which will have very small direct effect, if any, on the LSST observing scheduler. As part of future studies we will examin the effects of contrals on LSST observations.

An Investigation of CCD Charge Transfer and Detector Anomalies for a Low Light Level

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Dixon, Samantha; Aldering, Greg Scott; Domagalski, Rachel; Boone, Kyle; Fagrelius, Parker; Hayden, Brian; Perlmutter, Saul; Saunders, Clare; Sofiatti, Caroline

Abstract:

The SuperNova Integral Field Spectrograph (SNIFS) is used to obtain spectra of nearby Type Ia supernovae as part of the Nearby Supernova Factory. Charge transfer inefficiency (CTI) in the CCD detectors used on SNIFS has the potential to cause distortions to spectra and increase noise. We present a study of the CTI in the SNIFS CCDs using trails from cosmic rays in dark frames. This study shows that the effect of CTI on supernova spectra is minimal, and additionally reveals a detector anomaly, a 1 e- undershoot, that is correlated with lower temperatures of the SDSU ARC electronics. We will also present plans for the characterization of new, lower noise, faster readout CCDs from Lawrence Berkeley National Laboratory as part of an upgrade of SNIFS.

Do Single-Degenerate Type Ia Supernovae Generally Lead to Normal Type Ia Supernovae?

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Fisher, Robert

Abstract:

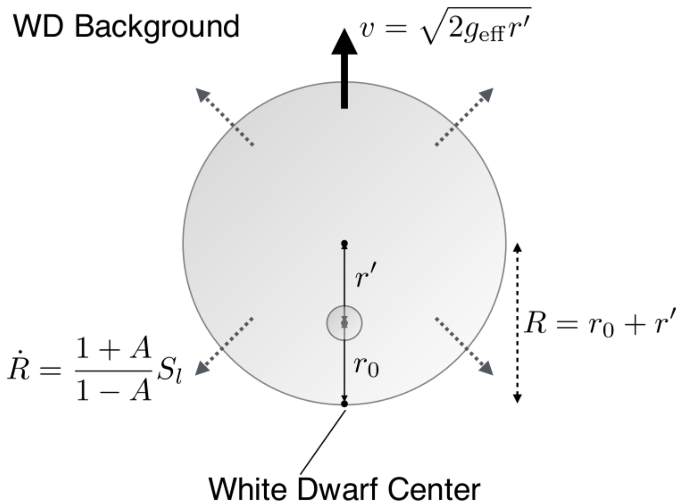
Recent observational and theoretical progress has favored merging and helium-accreting sub-Chandrasekhar mass white dwarfs (WDs) in the double-degenerate and the double-detonation channels, respectively, as the dominant progenitors of normal Type Ia supernovae (SNe Ia). Thus the fate of rapidly-accreting Chandrasekhar mass WDs in the single-degenerate channel remains more mysterious then ever. In this talk, I will clarify the nature of ignition in Chandrasekhar-mass single-degenerate SNe Ia and demonstrate that the overwhelming majority of ignition events within Chandrasekhar-mass WDs in the single-degenerate channel are generally expected to be buoyancy-driven, and consequently lack a vigorous deflagration phase. I will show, using both analytic criteria and multidimensional numerical simulations, that the single-degenerate channel is inherently stochastic and leads to a variety of outcomes from failed SN 2002cx-like events through overluminous SN 1991T-like events. I will also demonstrate how the rates predicted from both the population of supersoft X-ray sources (SSSs) and binary population synthesis models of the single-degenerate channel can be brought into agreement with single-degenerate SNe Ia. I will further demonstrate that the single-degenerate channel contribution to the normal and failed 2002cx-like rates is not likely to exceed 1% of the total SNe Ia rate. I will conclude with a range of observational tests which will either support or strongly constrain the single-degenerate scenario.

Claim: single-degenerate SNe Ia generally lack a vigorous deflagration phase, and preferentially result in overluminous SNe Ia. The overwhelming majority of ignition events within Chandrasekhar-mass white dwarfs in the single-degenerate channel are buoyancy-driven, and consequently lack a vigorous deflagration phase

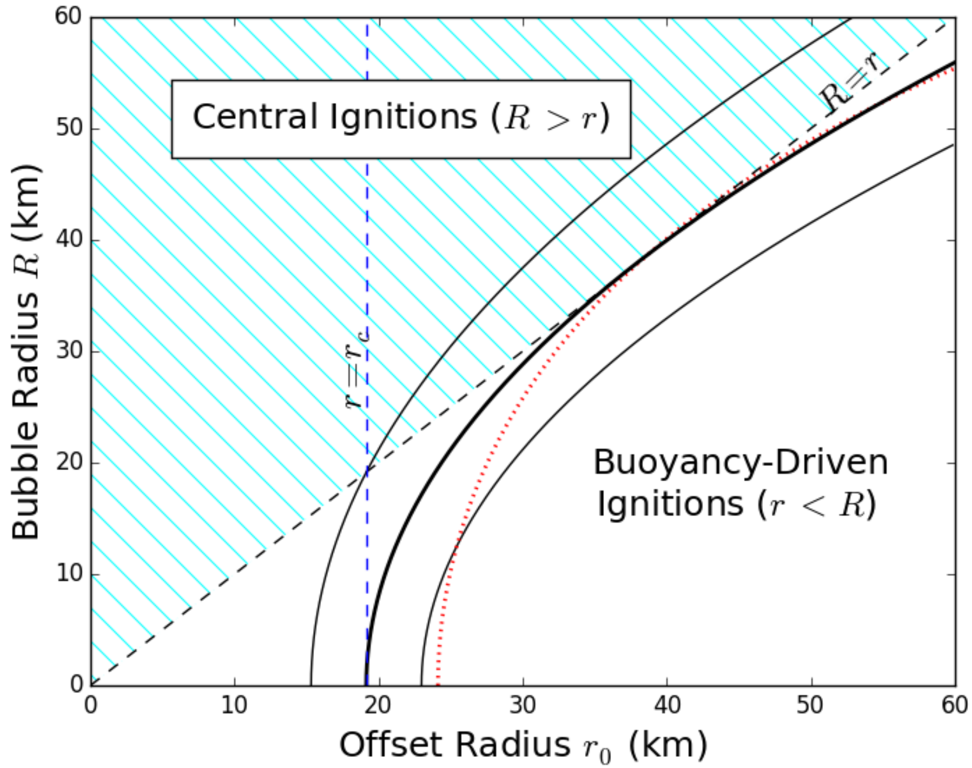
A single buoyancy-driven ignition point burns a small fraction of the white dwarf during the deflagration phase and consequently leads to small amounts of pre-expansion, consistent with an overluminous SNe Ia event. In contrast, central ignition points linger near the central region of the star, leading to greater pre-expansion, typically producing $\sim 0.5M$ of 56 Ni burnt during the deflagration phase.

Paper: [Single-Degenerate Type Ia Supernovae Are Preferentially Overluminous]

Do Single-Degenerate Type Ia Supernovae Generally Lead to Normal Type Ia Supernovae?



A schematic diagram depicting the geometry of the critical case of a bubble, ignited at a distance r 0 from the center of the star, which just barely begins to burn through the center of the star in the time required for it to buoyantly rise an additional vertical distance r . As shown, the radius R of the critical case bubble at the instant it begins to burn through the center of the star is R = r 0 + r .



A plot of bubble radius R versus offset radius r 0 . The dashed line R = r is the critical case separating central ignitions from buoyancy-driven ignitions. The hatched region of the figure marks central ignitions, with R > r; buoyancy-driven ignitions lie in the portion of the figure with r < R. The vertical dashed line shows the critical offset radius, and the solid lines denote the trajectories of the analytic solution described in the text, with the thick solid line showing the critical case of a bubble which barely burns through the center of the star. For comparison, a full numerical integration of a critical bubble in a fully-stratified WD, with an initial critical offset r cit = 24.1 km is shown in the dotted curve.

LSST Observing Strategy

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Ivezić, Željko

Abstract:

The science of the LSST will, in part, be driven by how it observes the sky (the footprint and cadence of the survey). I provide a brief overview of the ongoing community and Project work on LSST observing strategy, and pointers for how to join this effort.

Setup	Simulation Name	Description of the Survey Setup
0	enigma_1189	Modern Version of the Baseline Cadence A candidate replacement simulation for the current Baseline Cadence (opsim3.61) produced with the latest version (v3.2.1) of the Operations Simulation (OpSim) code. The following adjustments have been made: includes Science Council approved Deep Drilling fields; Wide-Fast-Deep (WFD) design specification for areal coverage (18,000 deg) & WFD "boosted visits" = 75, 105, 240, 240, 210, 210 for u, g, r, i, z, & y filters where g, r, i and z visits are collected in pairs separated by about 30 minutes; includes revised scheduled downtime as well as random downtime; minAlt = 20 deg; MinDistance2Moon = 30 deg. Note that SRD design visits = 56, 80, 184, 184, 160, 160 for u, g, r, i, z, & y filters.
1	ops2_1098	Uniform cadence (WFD), which asks for visits in pairs, and no other proposal.
2	ops2_1093	Only uniform cadence (WFD), but does not require pairs of visits.
3	kraken_1033	As the baseline cadence (Setup 0), but does not require pairs of visits.
4	enigma_1271 enigma_1266	As the baseline cadence, but requests 3 visits per Wide-Fast-Deep field chosen instead of 2 visits, using the same window function for both 1-2 visits and 2-3 visits. As the baseline cadence, but requests 4 visits per Wide-Fast-Deep field.
5	kraken_1034	As the baseline cadence, except that the u-band exposure time is 60 sec instead of 30 sec.; Nvisit for the u-band remains the same.
6	kraken_1035	As the baseline cadence, except that the u-band exposure time is 60 sec instead of 30 sec; Nvisit for the u-band is decreased by a factor of 2.
7	kraken_1036	As the baseline cadence, except for a shorter visit exposure time: 20 sec instead of 30 sec. Deep drilling proposal has visits based on 30sec exposure due to code issues.
8	kraken_1037	As the baseline cadence, except for a longer visit exposure time: 60 sec instead of 30 sec.
9	ops2_1092	Pan-STARRS-like Cadence This is the uniform cadence, and no other proposal, keeping pairs of visits, but increase the area to include everything with Dec <+15 deg (about 27,400 deg2), and keeping the default airmass limit of 1.5.
10	kraken_1038	As the baseline cadence, except for the more relaxed airmass limit of 2.0 instead of 1.5.
11	ops2_1096	As Setup1 (uniform cadence with no other proposal), except for the more relaxed airmass limit of 2.0 instead of 1.5.
12	ops2_1097	As Setup 1 (uniform cadence with no other proposal), except for the more stringent airmass limit of 1.3 instead of 1.5.

LSST Observing Strategy

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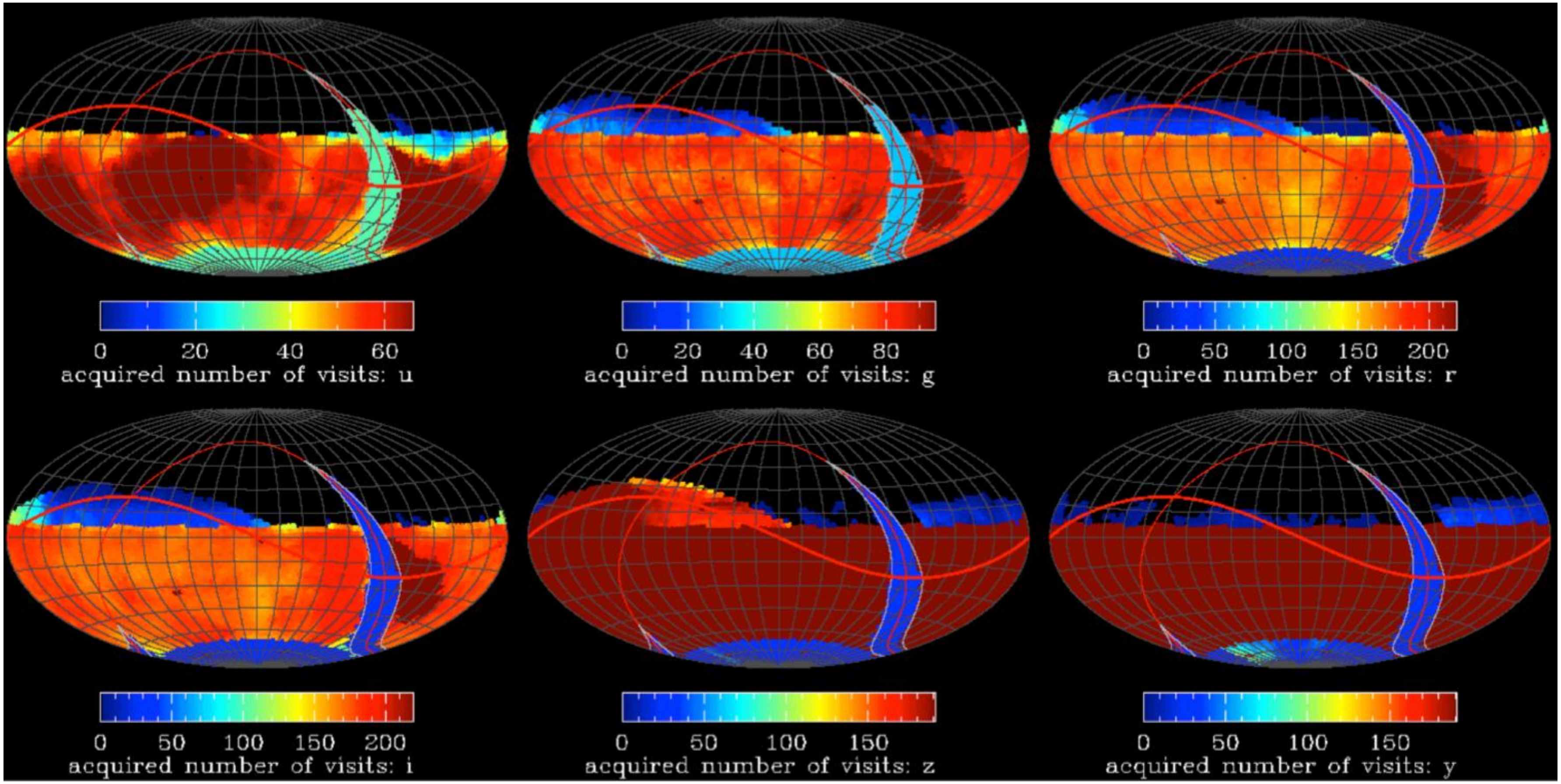
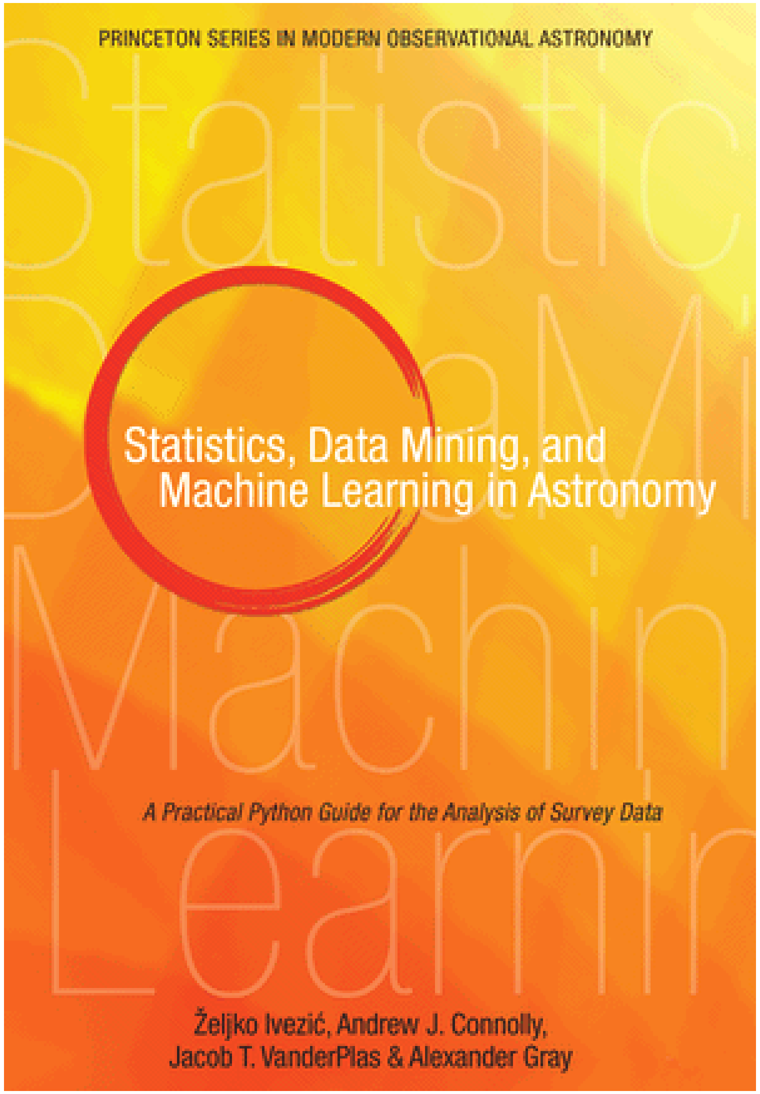


Bayesian Methods in Astronomy: Hands-on Statistics

VanderPlas, Jake

Summary:

With applications ranging from cosmological parameter constraints to detection of exoplanets, Bayesian methods are increasingly becoming an essential piece of the modern astronomer's computational tool belt. In this workshop, we will take a hands-on approach to learning the Bayesian approach in an astronomical context, starting with a brief overview of relevant background and moving into practical exercises in modeling increasingly complicated data using Markov Chain Monte Carlo (MCMC) methods. The workshop will consist of a mix of lectures and coding breakouts, focusing specifically on the use of Python tools such as the emcee package. To get the most out of this workshop, participants should be comfortable with Python as a computational tool, and come with their laptops ready to write code and run models. This workshop will be facilitated by Jake VanderPlas (U. Washington) along with two assistant facilitators. Jake VanderPlas is the Director of Research in Physical Sciences at the University of Washington's eScience Institute, an interdisciplinary program designed to support data-driven discovery in a wide range of scientific fields. His own research is in astronomy, astrostatistics, machine learning, and scalable computation. He is an active developer of open science tools in Python. He co-authored the book Statistics, Data Mining, and Machine Learning in Astronomy, and often leads courses and workshops on these topics.



LSST Posters and Presentations

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LSST @ AAS 227: https://zenodo.org/collection/user-lsst-aas227

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The Effects of Commercial Airline Traffic on LSST Observing Efficiency

Gibson, Rose ; Claver, Chuck ; Stubbs, Christopher

The Large Synoptic Survey Telescope Corporation: Preparing for Big Data

Eliason, Pat ; Osmer, Pat

The LSST Science Collaborations

Walkowicz, Lucianne

Large Synoptic Survey Telescope Town Hall

Willman, Beth

LSST Observing Strategy

Ivezić, Željko

Evaluating the LSST Science Pipelines with Precursor Datasets

Nidever, David L.

LSST and Synergies with the VO

Ciardi, David R.

The LSST Data Processing Software Stack

Jenness, Tim